

Apprenticeship and Industry Training

Heavy Equipment Technician Apprenticeship Course Outline

1912 (2012)

**Government
of Alberta ■**



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Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding an employer. Employers hire apprentices, pay their wages and provide on-the-job training and work experience. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyperson or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution – usually a college or technical institute.

To become certified journeypersons, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board on the recommendation of Heavy Equipment Technician Provincial Apprenticeship Committee.

The graduate of the Heavy Equipment Technician apprenticeship program is a certified journeyperson who will be able to:

- diagnose repair, and maintain by skills and knowledge gained through training and experience any of the working parts of diesel engines as well as the various components of mobile industrial equipment
- use, competently, both hand and power tools in order to carry out repairs according to manufacturer's specifications
- read and understand work orders, prepare estimates, and interpret technical manuals
- write service reports, diagnose the cause of failures and keep service analysis records
- when fully competent in all phases of general repairs, a Heavy Equipment Technician may specialise in any one of several areas of the trade such as, fuel pumps and injectors, track equipment, engine overhaul, hydraulic controls, power shift transmissions and allied equipment
- outstanding individuals may advance to service representatives or supervisory positions
- be familiar with the work in related trades such as Machinist and Welder
- understand the fundamentals of operating a small business.
- perform assigned tasks in accordance with quality and production standards required by industry.

Apprenticeship and Industry Training System

Industry-Driven

Alberta's apprenticeship and industry training system is an industry-driven system that ensures a highly skilled, internationally competitive workforce in more than 50 designated trades and occupations. This workforce supports the economic progress of Alberta and its competitive role in the global market. Industry (employers and employees) establishes training and certification standards and provides direction to the system through an industry committee network and the Alberta Apprenticeship and Industry Training Board. The Alberta government provides the legislative framework and administrative support for the apprenticeship and industry training system.

Alberta Apprenticeship and Industry Training Board

The Alberta Apprenticeship and Industry Training Board provides a leadership role in developing Alberta's highly skilled and trained workforce. The Board's primary responsibility is to establish the standards and requirements for training and certification in programs under the Apprenticeship and Industry Training Act. The Board also provides advice to the Minister of Enterprise and Advanced Education on the needs of Alberta's labour market for skilled and trained workers, and the designation of trades and occupations.

The thirteen-member Board consists of a chair, eight members representing trades and four members representing other industries. There are equal numbers of employer and employee representatives.

Industry Committee Network

Alberta's apprenticeship and industry training system relies on a network of industry committees, including local and provincial apprenticeship committees in the designated trades, and occupational committees in the designated occupations. The network also includes other committees such as provisional committees that are established before the designation of a new trade or occupation comes into effect. All trade committees are composed of equal numbers of employer and employee

representatives. The industry committee network is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the Board can set up a local apprenticeship committee. The Board appoints equal numbers of employee and employer representatives for terms of up to three years. The committee appoints a member as presiding officer. Local apprenticeship committees:

- monitor apprenticeship programs and the progress of apprentices in their trade, at the local level
- make recommendations to their trade's provincial apprenticeship committee (PAC) about apprenticeship and certification in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- make recommendations to the Board about the appointment of members to their trade's PAC
- help settle certain kinds of disagreements between apprentices and their employers
- carry out functions assigned by their trade's PAC or the Board

Provincial Apprenticeship Committees (PAC)

The Board establishes a provincial apprenticeship committee for each trade. It appoints an equal number of employer and employee representatives, and, on the PAC's recommendation, a presiding officer - each for a maximum of two terms of up to three years. Most PACs have nine members but can have as many as twenty-one. Provincial apprenticeship committees:

- make recommendations to the Board about:
 - standards and requirements for training and certification in their trade
 - courses and examinations in their trade
 - apprenticeship and certification
 - designation of trades and occupations
 - regulations and orders under the Apprenticeship and Industry Training Act
- monitor the activities of local apprenticeship committees in their trade
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- consult with other committees under the Apprenticeship and Industry Training Act about apprenticeship programs, training and certification and facilitate cooperation between different trades and occupations
- consult with organizations, associations and people who have an interest in their trade and with employers and employees in their trade
- may participate in resolving certain disagreements between employers and employees
- carry out functions assigned by the Board

Heavy Equipment Technician PAC Members at the time of publication.

Mr. M. Larson.....	Edmonton	Presiding Officer
Mr. D. Scott.....	Red Deer	Employer
Mr. G. Atkinson	Grand Prairie	Employer
Mr. M. Allen.....	Calgary	Employer
Mr. A. Nieuwenkamp	Spruce Grove	Employer
Mr. M. Tarrabain	Edmonton	Employer
Mr. R. Cosen.....	Calgary	Employee
Mr. P. Valgardson	Taber	Employee
Mr. A. Paananen.....	Stony Plain	Employee
Mr. R. Wizniak	Sherwood Park	Employee
Mr. M. Bordeleau	Bonnyville	Employee

Alberta Government

Alberta Enterprise and Advanced Education works with industry, employer and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and employers
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

Technical Institutes and Colleges

The technical institutes and colleges are key participants in Alberta's apprenticeship and industry training system. They work with the Board, industry committees and Alberta Enterprise and Advanced Education to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs. They develop lesson plans from the course outlines established by industry and provide technical training to apprentices.

Apprenticeship Safety

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

Alberta Apprenticeship and Industry Training Board Safety Policy

The Alberta Apprenticeship and Industry Training Board (board) fully supports safe learning and working environments and emphasizes the importance of safety awareness and education throughout apprenticeship training- in both on-the- job training and technical training. The board also recognizes that safety awareness and education begins on the first day of on-the-job training and thereby is the initial and ongoing responsibility of the employer and the apprentice as required under workplace health and safety training. However the board encourages that safe workplace behaviour is modeled not only during on-the-job training but also during all aspects of technical training, in particular, shop or lab instruction. Therefore the board recognizes that safety awareness and training in apprenticeship technical training reinforces, but does not replace, employer safety training that is required under workplace health and safety legislation.

The board has established a policy with respect to safety awareness and training:

The board promotes and supports safe workplaces, which embody a culture of safety for all apprentices, employers and employees. Employer required safety training is the responsibility of the employer and the apprentice, as required under legislation other than the *Apprenticeship and Industry Training Act*.

The board's complete document on its 'Apprenticeship Safety Training Policy' is available at www.tradesecrets.gov.ab.ca; access the website and conduct a search for 'safety training policy'.

Implementation of the policy includes three common safety learning outcomes and objectives for all trade course outlines. These common learning outcomes ensure that each course outline utilizes common language consistent with workplace health and safety terminology. Under the title of 'Standard Workplace Safety', this first section of each trade course outline enables the delivery of generic safety training; technical training providers will provide trade specific examples related to the content delivery of course outline safety training.

Workplace Health and Safety

A tradesperson is often exposed to more hazards than any other person in the work force and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Workplace Health and Safety (Alberta Employment and Immigration) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.worksafely.org

Technical Training

Apprenticeship technical training is delivered by the technical institutes and many colleges in the public post-secondary system throughout Alberta. The colleges and institutes are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All training providers place great emphasis on safe technical practices that complement safe workplace practices and help to develop a skilled, safe workforce.

The following technical training providers deliver Heavy Equipment Technician apprenticeship training:

Northern Alberta Institute of Technology	Lakeland College
Southern Alberta Institute of Technology	Lethbridge College
Keyano College	Grande Prairie Regional College
Medicine Hat College	Red Deer College
Olds College	

Procedures for Recommending Revisions to the Course Outline

Enterprise and Advanced Education has prepared this course outline in partnership with the Heavy Equipment Technician Provincial Apprenticeship Committee.

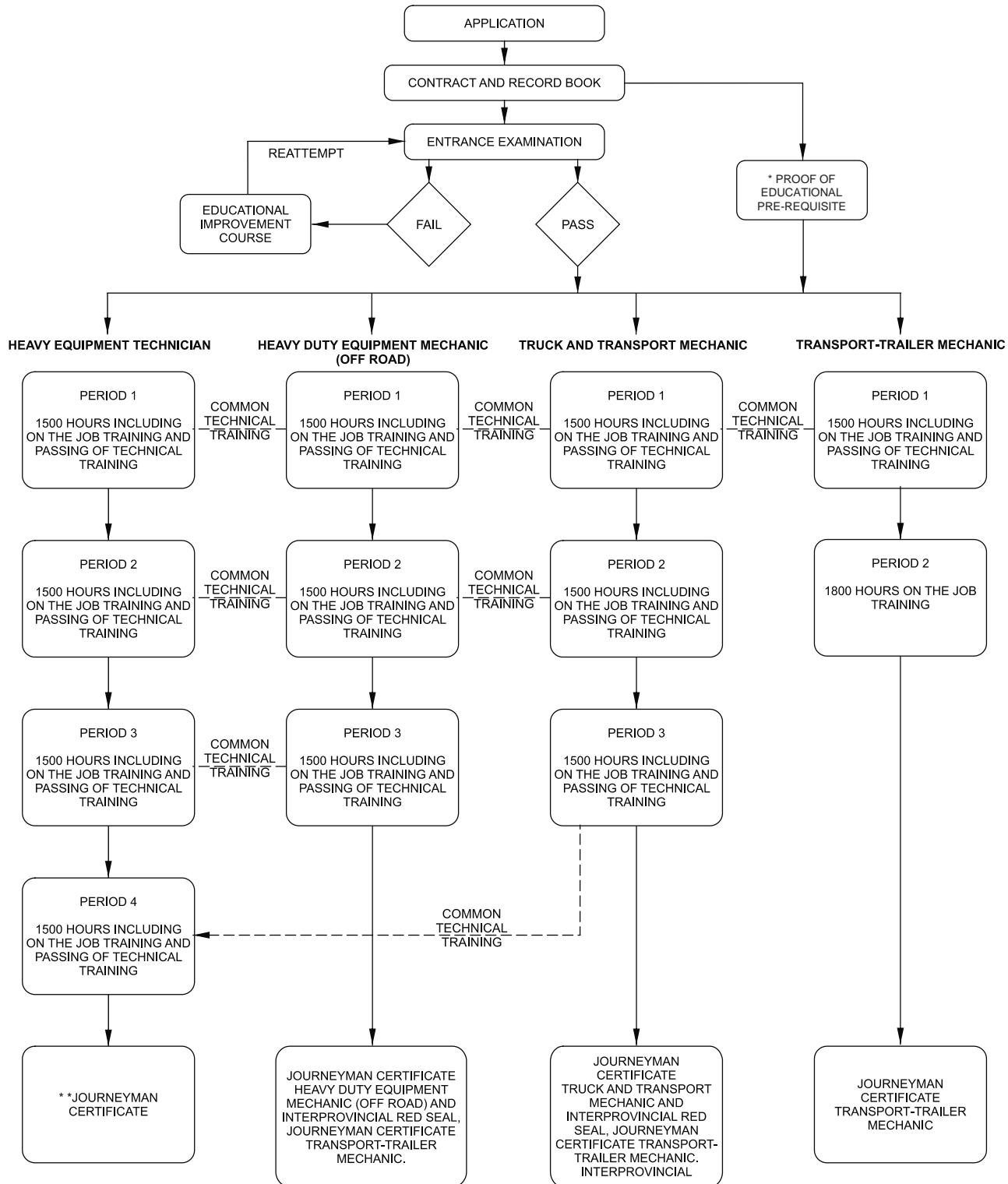
This course outline was approved on December 9, 2011 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

Heavy Equipment Technician Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
Enterprise and Advanced Education
10th floor, Commerce Place
10155 102 Street NW
Edmonton AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations for change will be placed on the agenda for regular meetings of the Heavy Equipment Technician Provincial Apprenticeship Committee.

APPRENTICESHIP ROUTE TOWARDS CERTIFICATION



* FOR ENTRANCE REQUIREMENTS RECOMMENDED PATH AS WELL AS MINIMUM REQUIREMENTS, REFER TO <www.tradesecrets.gov.ab.ca>

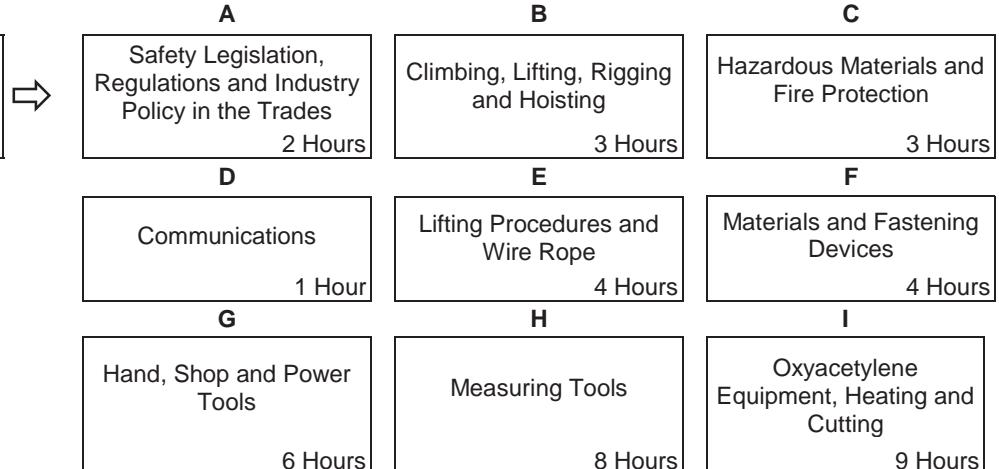
** A PERSON HOLDING A "JOURNEYMAN HEAVY EQUIPMENT TECHNICIAN" CERTIFICATE WILL RECEIVE THE TRANSPORT-TRAILER MECHANIC, TRUCK AND TRANSPORT MECHANIC, AND THE HEAVY DUTY EQUIPMENT MECHANIC (OFF ROAD) CERTIFICATES. CANDIDATES ARE ALSO ELIGIBLE TO RECEIVE THE INTERPROVINCIAL RED SEAL FOR TRUCK AND TRANSPORT MECHANIC AND THE HEAVY DUTY EQUIPMENT MECHANIC (OFF ROAD).

Heavy Equipment Technician Training Profile
FIRST PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

STANDARD WORKPLACE SAFETY, MATERIALS AND TOOLS

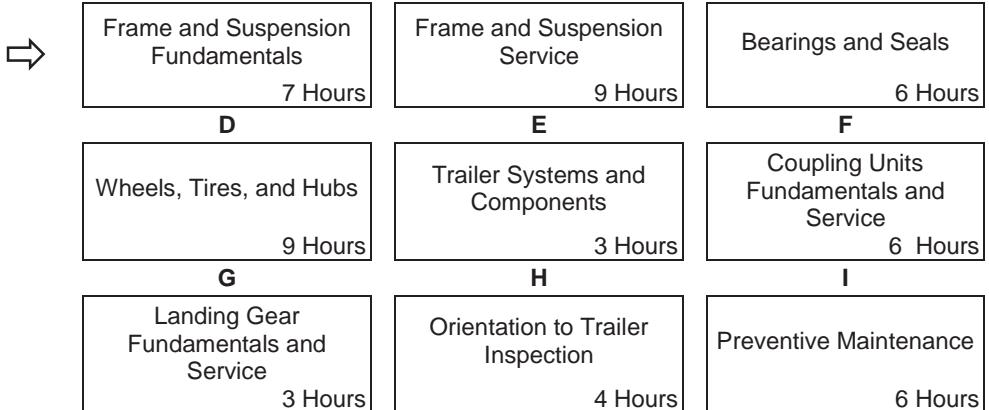
40 HOURS



SECTION TWO

SUSPENSIONS, WHEELS AND SYSTEMS

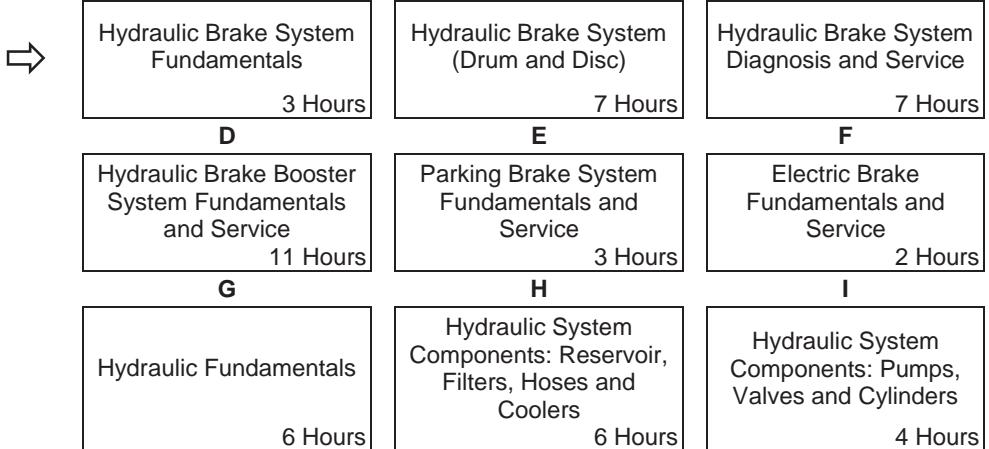
53 HOURS



SECTION THREE

HYDRAULICS 1 AND HYDRAULIC BRAKE SYSTEMS

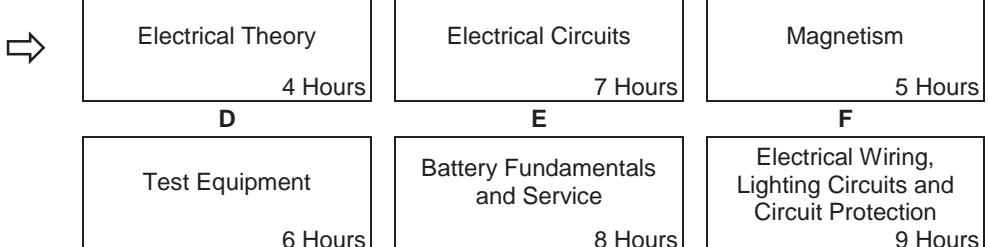
49 HOURS

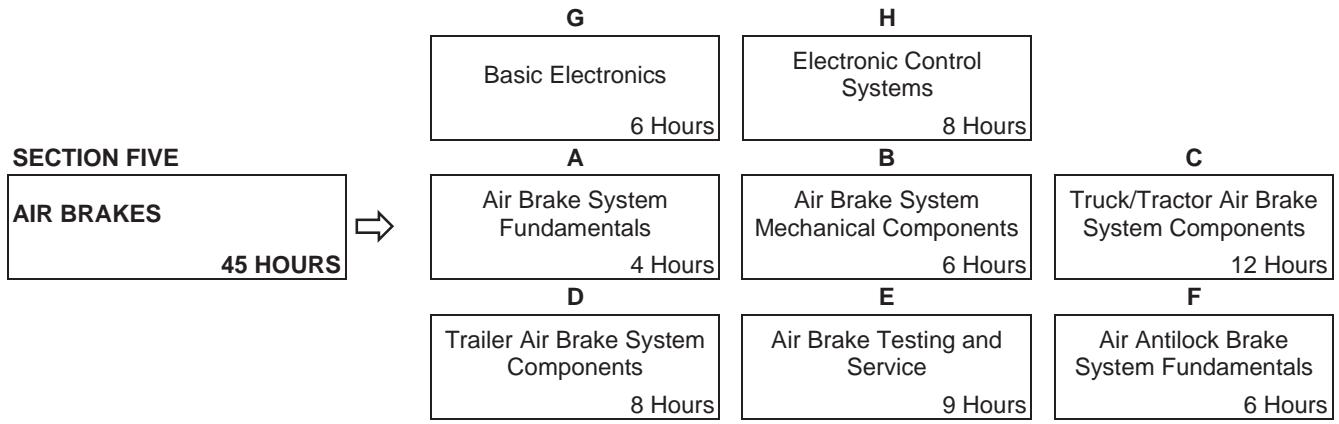


SECTION FOUR

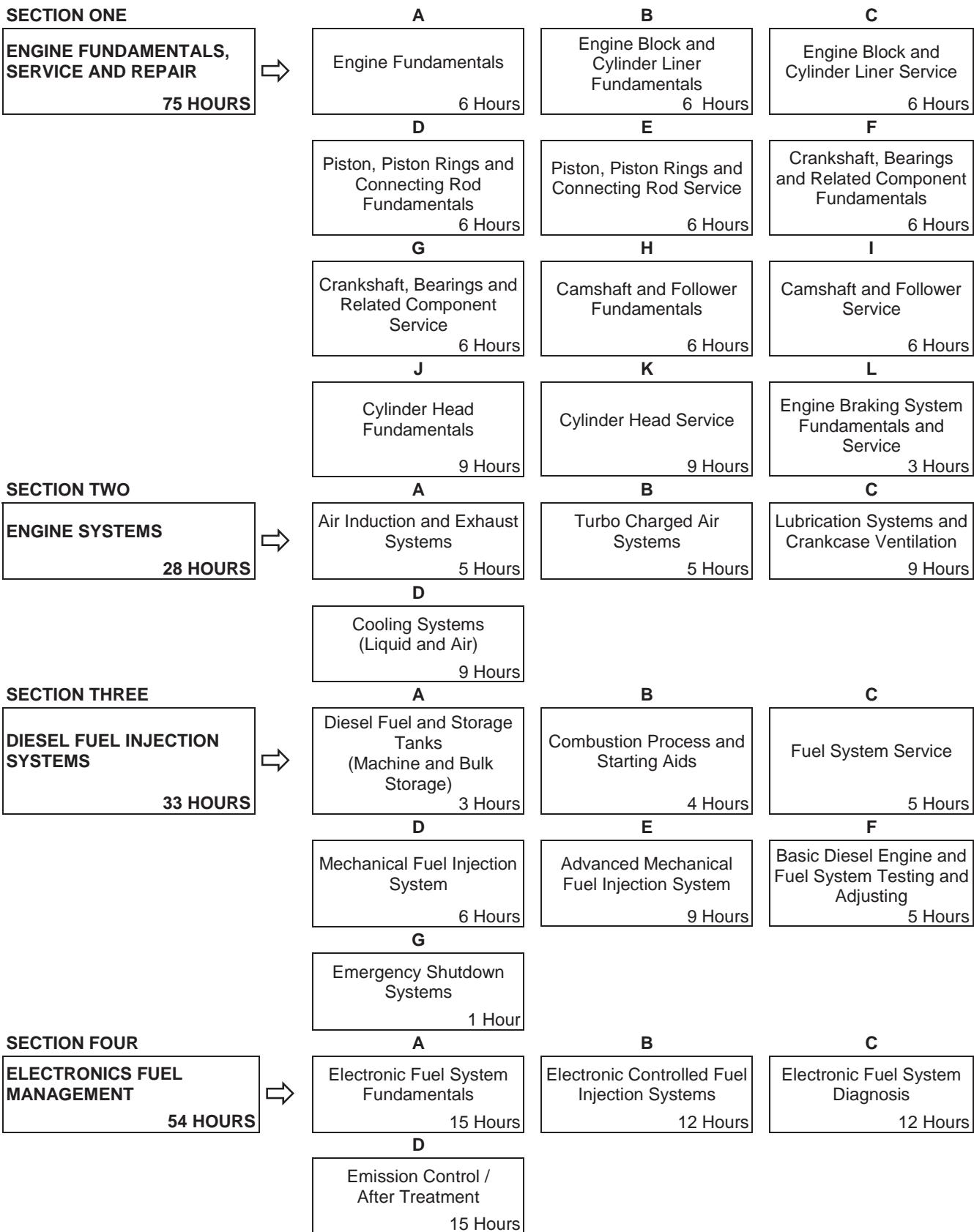
ELECTRICAL I AND ELECTRONICS I

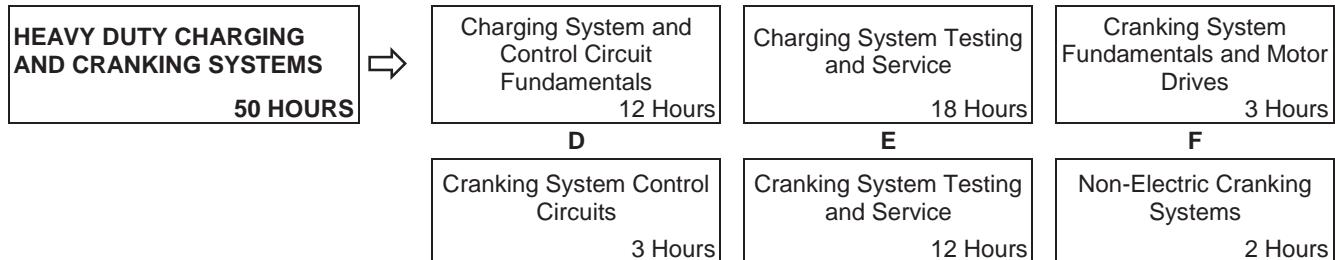
53 HOURS



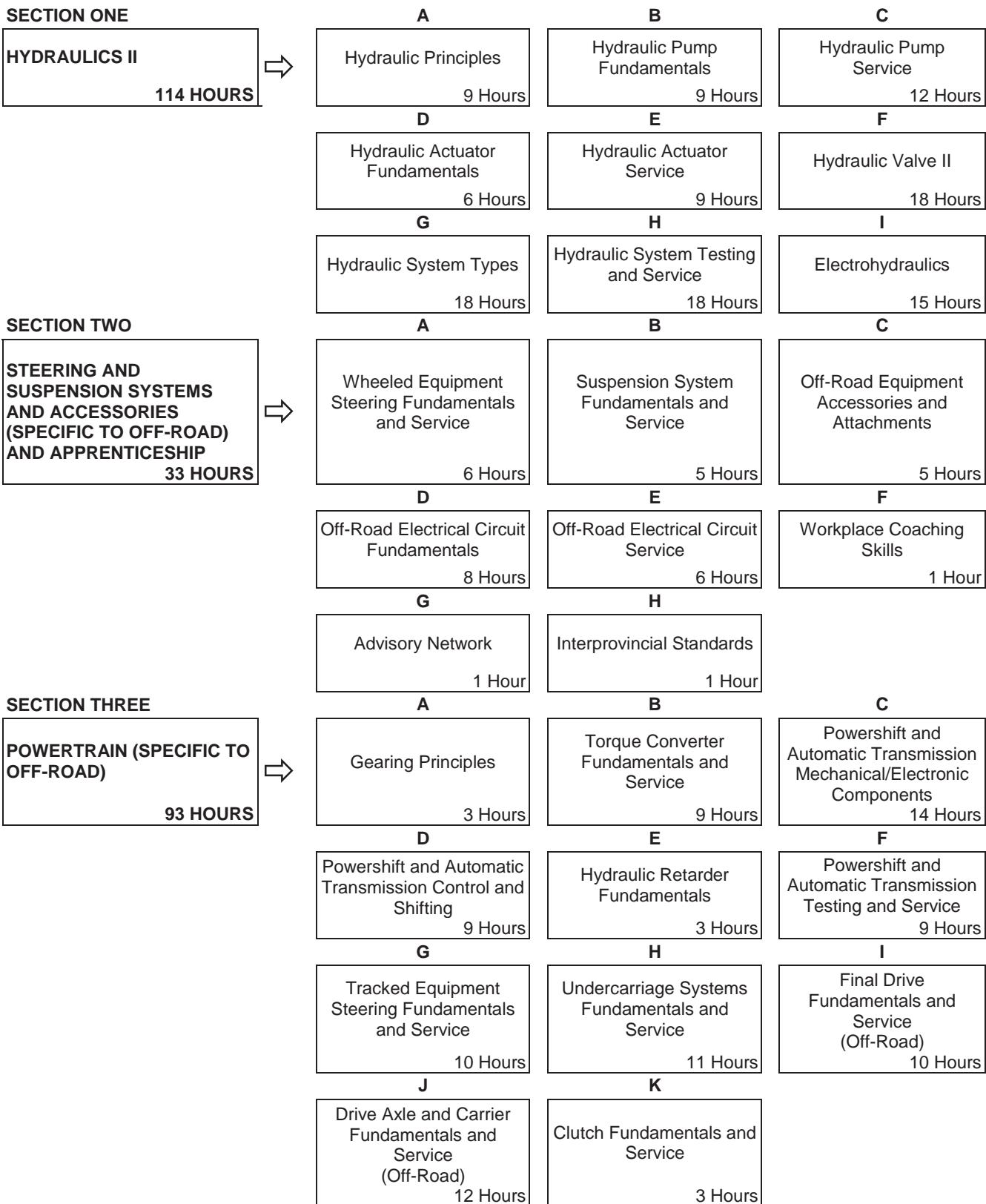


SECOND PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

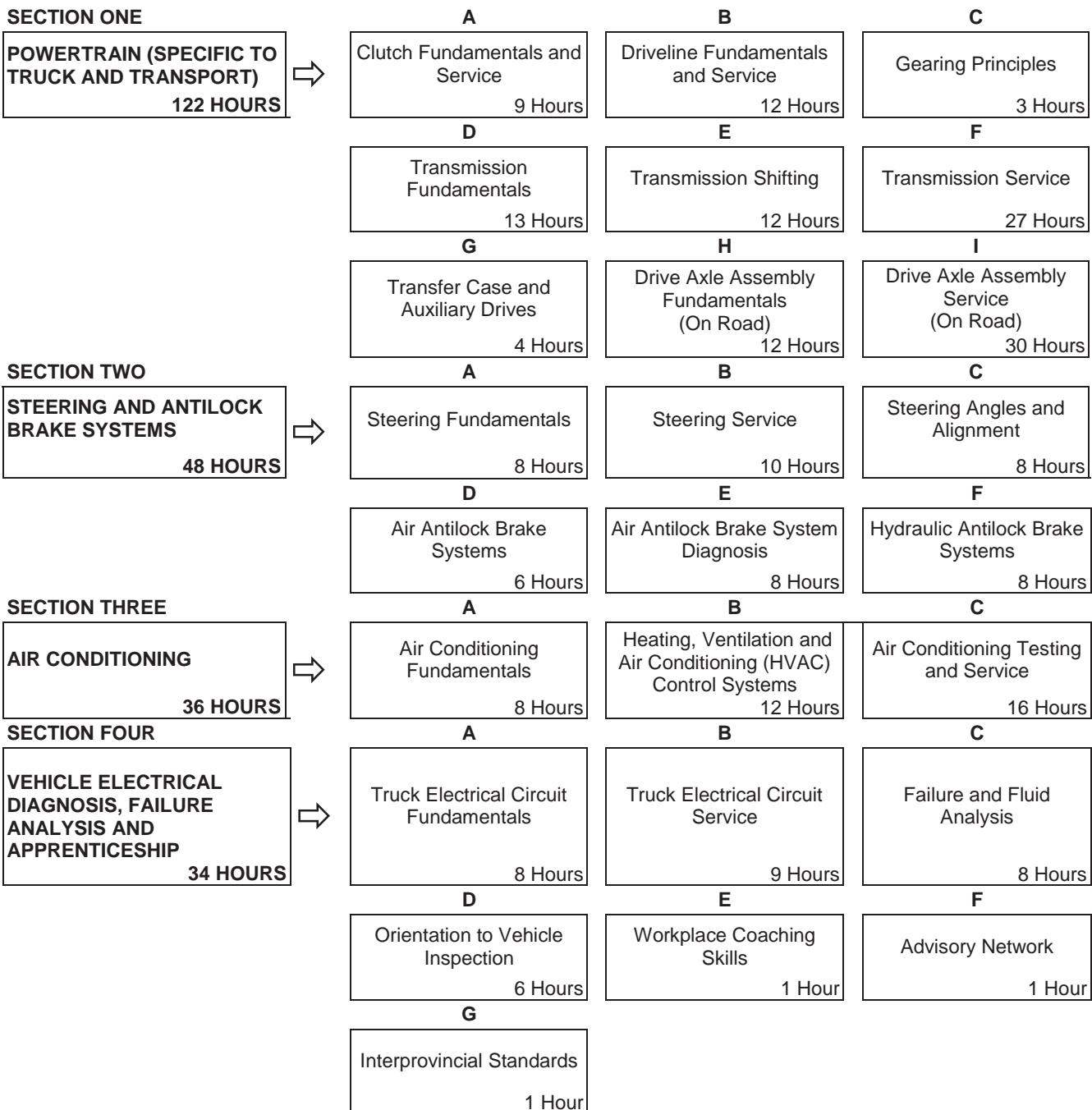


SECTION FIVE

THIRD PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)



FOURTH PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)



NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training.

**FIRST PERIOD TECHNICAL TRAINING
HEAVY EQUIPMENT TECHNICIAN TRADE
COURSE OUTLINE**

**UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO
PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.**

SECTION ONE:.....STANDARD WORKPLACE SAFETY MATERIALS AND TOOLS 40 HOURS

A. Safety Legislation, Regulations and Industry Policy in the Trades 2 Hours

Outcome: *Describe legislation, regulations and practices intended to ensure a safe work place in this trade.*

1. Demonstrate the ability to apply the Occupational Health and Safety Act, Regulation and Code.
2. Explain the role of the employer and employee in regard to Occupational Health and Safety (OH&S) regulations, Worksite Hazardous Materials Information Systems (WHMIS), fire regulations, Workers Compensation Board regulations, and related advisory bodies and agencies.
3. Explain industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of workers and employers to apply emergency procedures.
5. Describe positive tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of employers and employees with respect to the selection and use of personal protective equipment (PPE).
7. Select, use and maintain appropriate PPE for worksite applications.

B. Climbing, Lifting, Rigging and Hoisting 3 Hours

Outcome: *Describe the use of personal protective equipment (PPE) and safe practices for climbing, lifting, rigging and hoisting in this trade.*

1. Select, use and maintain specialized PPE for climbing, lifting and load moving equipment.
2. Describe manual lifting procedures using correct body mechanics.
3. Describe rigging hardware and the safety factor associated with each item.
4. Select the correct equipment for rigging typical loads.
5. Describe hoisting and load moving procedures.

C. Hazardous Materials and Fire Protection 3 Hours

Outcome: *Describe the safety practices for hazardous materials and fire protection in this trade.*

1. Describe the roles, responsibilities features and practices related to the workplace hazardous materials information system (WHMIS) program.
2. Describe the three key elements of WHMIS.
3. Describe handling, storing and transporting procedures when dealing with hazardous material.
4. Describe safe venting procedures when working with hazardous materials.
5. Describe fire hazards, classes, procedures and equipment related to fire protection.

D. Communications 1 Hour

Outcome: *Demonstrate communication skills and workshop safety as it pertains to Occupational Health and Safety standards.*

1. Communicate trade-related information using standards terms for components and operations.
2. Identify key areas of responsibility that an employee has in regards to shop and trade safety.
3. Explain correct use of fire extinguishers.

E. Lifting Procedures and Wire Rope 4 Hours

Outcome: *Perform lifting operations using proper techniques and equipment as it pertains to Occupational Health and Safety standards.*

1. Describe manual lifting operations using correct body mechanics.
2. Describe lifting equipment, grading, sizing and limits.
3. Select equipment for rigging typical loads.
4. Describe applications of wire rope on machinery following regulations set out by the Occupational Health and Safety Act.
5. Demonstrate the correct use of jacking and blocking techniques common to off-road and on-road equipment and trailers.

F. Materials and Fastening Devices 4 Hours

Outcome: *Identify materials and fasteners commonly used in the trade.*

1. Identify common metallic materials and their applications.
2. Identify common non-metallic materials and their applications.
3. Identify types of threaded fasteners and their applications.
4. Explain the torque procedures and precautions required when securing fastening devices.
5. Identify types of non-threaded fasteners and their applications.

G. Hand, Shop and Power Tools 6 Hours

Outcome: *Demonstrate the correct use of hand, shop and power tools common to the trade.*

1. Describe types, uses and care of hand tools.
2. Describe the procedures required to safely operate various types and capacities of shop puller and pressing equipment.
3. Describe and use cutting hand tools common to the trade.
4. Demonstrate proper care and safe use of common power hand tools.

H. Measuring Tools 8 Hours

Outcome: *Demonstrate the correct use of measuring tools common to the trade.*

1. Perform calculations related to measurement using imperial and metric units.
2. Perform linear measurements using basic measuring tools.
3. Perform linear measurements using precision measuring tools.
4. Perform accurate torque measurements using torquing tools.

FIRST PERIOD

I. Oxyacetylene, Equipment, Heating and Cutting.....9 Hours

Outcome: *Perform metal cutting and heating operations safely using oxyacetylene equipment.*

1. Describe the characteristics and handling procedures for oxygen, propane and acetylene.
2. Demonstrate handling procedures for regulators and hoses.
3. Demonstrate the use, care, and maintenance of torches and tips.
4. Demonstrate the use of personal protective equipment.
5. Perform heating and cutting operations using oxygen and acetylene.

SECTION TWO:.....SUSPENSIONS, WHEELS AND SYSTEMS53 HOURS

A. Frame and Suspension Fundamentals.....7 Hours

Outcome: *Explain the operating principles and design features of common frame and suspension systems.*

1. State the functions of a vehicle frame.
2. Identify types, designs and components of frames commonly used in truck and trailer applications.
3. State the functions of a vehicle suspension system.
4. Explain the operating principles of common suspension systems.

B. Frame and Suspension Service9 Hours

Outcome: *Repair common types of frame and suspension systems.*

1. Explain frame inspection and repair procedures.
2. Explain the causes of suspension system malfunction.
3. Explain suspension system repair procedures.

C. Bearings and Seals.....6 Hours

Outcome: *Service common bearings and seals.*

1. State bearing functions and applications.
2. State seal functions and applications.
3. Diagnose common bearing and seal faults.
4. Perform bearing and seal service.

D. Wheels, Tires and Hubs9 Hours

Outcome: *Service wheels, tires and hubs.*

1. Identify common wheel types and mounting designs.
2. Explain tire construction, care and maintenance in relation to design.
3. State the safety procedures required when handling wheels and tires.
4. Perform wheel removal, inspection and installation.
5. Explain wheel balancing.
6. Diagnose wheel and tire faults.

FIRST PERIOD

E. Trailer Systems and Components.....3 Hours

Outcome: *Identify common trailer systems and components.*

1. Describe types and configurations of on-highway trailers.
2. Identify trailer configurations according to number of axles and hitch points.
3. Identify trailer axle configurations; fixed and steering.

F. Coupling Units Fundamentals and Service.....6 Hours

Outcome: *Service trailer coupling systems and landing gear.*

1. Identify common types of trailer coupling units.
2. Service a fifth wheel assembly.
3. Service a no-slack pintle hitch.
4. Explain procedures and safety precautions required when coupling and uncoupling trailer systems.

G. Landing Gear Fundamentals and Service3 Hours

Outcome: *Service trailer coupling systems and landing gear.*

1. Identify common types of trailer landing gear.
2. Service common types of trailer landing gear.

H. Orientation To Trailer Inspection4 Hours

Outcome: *Explain trailer inspection according to CVI regulations.*

1. Outline trailer inspection regulations.
2. Identify conditions caused by damage, wear or corrosion, which would make a trailer unsafe or inoperable.

I. Preventive Maintenance.....6 Hours

Outcome: *Explain typical maintenance programs used with off-road and on road equipment.*

1. Explain the types of maintenance systems.
2. Explain the principles of preventive maintenance.
3. Explain the principles of predictive maintenance.
4. Demonstrate basic preventive maintenance and service procedures.

SECTION THREE: HYDRAULICS 1 AND HYDRAULIC BRAKE SYSTEMS..... 49 HOURS

A. Hydraulic Brake System Fundamentals3 Hours

Outcome: *Apply scientific principles to braking system operation.*

1. Explain braking principles with emphasis on heat, friction and hydraulic forces.
2. Explain brake fluids with regards to properties and handling procedures.

B. Hydraulic Brake System (Drum and Disc).....7 Hours

Outcome: *Explain the operation of hydraulic drum and disc brake systems.*

1. Explain the principles of operation of drum brake systems.

2. Explain the principles of operation of disc brake systems.
3. Explain the construction and operation of master cylinders.
4. Explain the purpose and construction of brake lines and hoses.
5. Explain the construction and operation of wheel cylinders and calipers.
6. Explain the purpose and operation of the metering, proportioning and pressure differential valves.

C. Hydraulic Brake System Diagnosis and Service 7 Hours

Outcome: *Service hydraulic drum and disc brake systems.*

1. List safety responsibilities required when servicing and repairing brake systems.
2. Diagnose brake system faults.
3. Service a typical drum brake assembly.
4. Service a typical disc brake assembly.
5. Describe reconditioning procedures required for master cylinders, wheel cylinders and brake calipers.
6. Demonstrate brake flushing and bleeding procedures on hydraulic brake systems.

D. Hydraulic Brake Booster System Fundamentals and Service 11 Hours

Outcome: *Explain power braking systems service procedures.*

1. Identify common power assist braking systems.
2. Explain the principles of operation for vacuum brake booster systems.
3. Describe the diagnosis and repair procedures for vacuum brake booster systems.
4. Explain the principles of operation for air-over-hydraulic brake booster systems.
5. Describe the diagnosis and repair procedures for air-over-hydraulic brake booster systems.
6. Explain the principles of operation for hydraulic-over-hydraulic brake booster systems.
7. Describe the diagnosis and repair procedures for hydraulic-over-hydraulic brake booster systems.

E. Parking Brake System Fundamentals and Service 3 Hours

Outcome: *Explain service procedures of parking brake systems.*

1. Explain the principles of operation for common parking brake systems.
2. Describe the adjusting procedures for common parking brake systems.
3. Describe repair procedures for common parking brake systems.

F. Electric Brake Fundamentals and Service 2 Hours

Outcome: *Explain service procedures of electric braking systems.*

1. Explain the principles of operation for electric braking systems.
2. Identify basic electric braking system failures.

G. Hydraulic Fundamentals 6 Hours

Outcome: *Explain hydraulic principles.*

1. Define hydraulic terminology.

2. Using mathematical calculations, explain the hydraulic principles of pressure, force, area.
3. Draw and interpret basic hydraulic schematics.
4. State the safety precautions that must be observed when working with hydraulic systems.

H. Hydraulic System Components: Reservoir, Filters, Hoses and Coolers 6 Hours

Outcome: *Explain the function of the following hydraulic system components; hydraulic oils, reservoirs, filters, conductors, and heat exchangers.*

1. Explain the properties of hydraulic fluid and the criteria for its selection.
2. State the functions of the hydraulic reservoir and its related components.
3. State the functions and principles of operation of filtration devices.
4. Explain the construction and applications of common types of hydraulic conductors.
5. State the functions and applications of hydraulic heat exchangers.

I. Hydraulic System Components: Pumps, Valves and Cylinders 4 Hours

Outcome: *Explain the functions and principles of operation of hydraulic system components.*

1. Explain gear pump operating principles.
2. Explain the principles of operation of the basic types of hydraulic control valves (direct acting pressure relief valve, open center directional control valve).
3. Explain the principles of operation of basic hydraulic cylinders.

SECTION FOUR: ELECTRICAL I AND ELECTRONICS I 53 HOURS

A. Electrical Theory 4 Hours

Outcome: *Apply scientific principles to explain electrical theory.*

1. Explain the physical properties of conductors, semi-conductors and insulators.
2. Explain electricity in terms of voltage, current and resistance.
3. Explain direct current, alternating current and static electricity.

B. Electrical Circuits 7 Hours

Outcome: *Identify electrical circuit types and circuit defects.*

1. List the components of a basic electrical circuit.
2. Identify the three circuit types and their properties.
3. Explain electrical laws and formulas that apply to the operation of electrical circuits.
4. Apply electrical laws and formulas to mathematically calculate circuit values.
5. Explain the effects of circuit defects on circuit operation.

C. Magnetism 5 Hours

Outcome: *Apply scientific principles to explain the theory of magnetism.*

1. Explain the fundamental laws of magnetism.
2. Explain the properties and applications of permanent magnets.
3. Explain the construction, operation and application of electromagnets.
4. Explain the principles of electromagnetic induction.

D. **Test Equipment** 6 Hours

Outcome: *Use electrical test equipment to measure electrical values and check circuit operation.*

1. Explain the construction and operation of voltmeters, ammeters and ohmmeters.
2. Explain meter precautions when measuring voltage, current and resistance.
3. Measure voltage at various points on a circuit and interpret the results.
4. Measure current flow at various points on a circuit and interpret the results.
5. Measure resistance using an ohmmeter.

E. **Battery Fundamentals and Service** 8 Hours

Outcome: *Service, test and charge a lead-acid battery.*

1. Identify hazards encountered with lead-acid storage batteries.
2. Explain battery construction, sizing and capacity.
3. Perform battery maintenance and testing.
4. List safety precautions and procedures for boosting batteries.
5. List the safety precautions and procedures for charging batteries.
6. Explain multiple battery circuits in relation to connections and battery compatibility.

F. **Electrical Wiring, Lighting Circuits and Circuit Protection** 9 Hours

Outcome: *Test and repair electrical circuits.*

1. Trace electrical circuits using symbols that are common to the industry.
2. Perform wiring harness inspection and repair.
3. Identify and repair wiring harness connectors that are common to the industry.
4. Test circuit protection devices, switches, relays and solenoids.
5. Repair an electrical lighting circuit for a short circuit, ground fault, open circuit and high resistance.

G. **Basic Electronics** 6 Hours

Outcome: *Test discrete electronic components used in the trade.*

1. Compare and contrast solid state electronic and electrical circuitry.
2. Explain the properties, applications and test procedures for resistors.
3. Explain the properties, applications and test procedures for diodes.
4. Identify the conditions that affect the life of electronic devices.

H. **Electronic Control Systems** 8 Hours

Outcome: *Describe the operation of basic computer-controlled systems.*

1. Identify the terminology commonly used with computer controls and components.
2. Explain the function of electronic control system components.
3. Explain the interaction between inputs, processors and outputs and multiplexing to control a circuit or a system.
4. Identify electronic test equipment used for diagnosis of electronic systems.

SECTION FIVE:.....AIR BRAKES45 HOURS**A. Air Brake System Fundamentals.....4 Hours**

Outcome: *Explain the fundamental principles of operation of an air brake system.*

1. Explain the principles of operation of an air brake system.
2. Develop a simple air brake system consisting of a compressor, dryer, reservoir, brake valve, steer axle and drive axle brake chambers, and connecting lines.

B. Air Brake System Mechanical Components.....6 Hours

Outcome: *Explain the operating principles of air brake mechanical components.*

1. Explain the operating principles of a typical cam-operated foundation brake.
2. Explain the operating principles of a typical air disc foundation brake.

C. Truck/Tractor Air Brake System Components.....12 Hours

Outcome: *Explain the principles of operation of truck/tractor air brake systems.*

1. Explain the functions and principles of operation of common air brake supply circuit components.
2. Explain the functions and principles of operation of common primary service brake circuit components.
3. Explain the functions and principles of operation of common secondary service brake circuit components.
4. Explain the functions and principles of operation of common parking/emergency brake circuit components.
5. Explain the functions and principles of operation of common trailer control circuit components.

D. Trailer Air Brake System Components8 Hours

Outcome: *Explain the principles of trailer brake system component operation.*

1. Explain the functions and principles of operation of pre-CMVSS 121 single trailer brake circuit components.
2. Explain the functions and principles of operation of CMVSS 121 single trailer brake circuit components.
3. Explain functions and principles of operation of common components used on multiple trailer combinations.

E. Air Brake System Testing and Service9 Hours

Outcome: *Service and diagnose truck/tractor and trailer air brake systems.*

1. State the safety precautions that must be observed prior to performing air brake system testing and service.
2. Perform a visual inspection of the air brake system.
3. Perform air brake system testing.
4. Analyse test results and state possible causes for system malfunction.
5. Service cam-operated foundation brakes.

F. Air Antilock Brake System Fundamentals 6 Hours

Outcome: *Describe the basic operation of an air antilock brake system.*

1. List the advantages of operating a vehicle equipped with an antilock brake system.
2. Explain the operation of an antilock air brake system.
3. Identify typical system layout and component locations on a vehicle equipped with an antilock air brake system.
4. Describe antilock air brake system service precautions.

**SECOND PERIOD TECHNICAL TRAINING
HEAVY EQUIPMENT TECHNICIAN TRADE
COURSE OUTLINE**

**UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO
PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.**

SECTION ONE:.....ENGINE FUNDAMENTALS, SERVICE AND REPAIR 75 HOURS

A. Engine Fundamentals..... 6 Hours

Outcome: *Explain the operating principles and design features of two and four stroke internal combustion engines.*

1. Explain the stages of development of the internal combustion engine.
2. Explain common engine terms and definitions.
3. Explain common methods of classifying engines.
4. Explain the principles of operation for two and four stroke cycle engines.
5. Compare diesel and gasoline engine operation.

B. Engine Block and Cylinder Liner Fundamentals 6 Hours

Outcome: *Describe the functions and design features of cylinder block assemblies.*

1. State the functions of the engine cylinder block.
2. Identify cylinder block construction and design features.
3. Describe the construction and design features of removable cylinder liners.

C. Engine Block and Cylinder Liner Service..... 6 Hours

Outcome: *Inspect an engine block assembly for serviceability.*

1. Inspect engine blocks for cracks, thread, bearing bore and machined surface condition.
2. Explain cylinder block repair procedures for cracks, threads, bearing bores and machined surfaces.
3. Explain inspection and reconditioning procedures for a cylinder block with integral cylinders.
4. Perform removable cylinder liner service.

D. Piston, Piston Rings and Connecting Rod Fundamentals 6 Hours

Outcome: *Describe the functions and design features of pistons, piston rings and connecting rods.*

1. Explain the function, construction and design features of pistons and piston pins.
2. Explain the function, construction and design features of piston rings.
3. Explain the function, construction and design features of connecting rods.

E. Piston, Piston Rings and Connecting Rod Service.....6 Hours***Outcome: Service a piston and connecting rod assembly.***

1. Remove and disassemble piston and connecting rod assemblies.
2. Inspect piston and pin for reuse.
3. Explain connecting rod service procedures.
4. Install piston and connecting rod assemblies.

F. Crankshaft, Bearings and Related Component Fundamentals.....6 Hours***Outcome: Describe the functions and design features of crankshafts and their related components.***

1. Explain the function and design features of crankshafts.
2. Explain methods used to achieve engine balance.
3. State the functions of crankshaft seals, gears and flywheels.
4. Describe the function and design features of friction bearings specific to engines.
5. Explain the lubrication principles of engine friction bearings.

G. Crankshaft, Bearings and Related Component Service6 Hours***Outcome: Service crankshafts, friction bearings and related components.***

1. Remove crankshaft and bearings from an engine block.
2. Inspect and measure crankshafts to determine serviceability.
3. Inspect flywheel and vibration damper to determine serviceability.
4. Identify common crankshaft and bearing failures.
5. Install crankshafts and related components.

H. Camshaft and Follower Fundamentals.....6 Hours***Outcome: Describe the functions and design features of camshafts and related components.***

1. Explain the function and design features of camshafts, camshaft bearings and seals.
2. Explain the function and design features of camshaft followers.
3. Explain camshaft drive mechanisms and timing.

I. Camshaft and Follower Service6 Hours***Outcome: Service camshaft and related components.***

1. Remove camshaft and related components from an engine block.
2. Inspect and measure camshafts and related components to determine serviceability.
3. Install camshaft and related components.

J. Cylinder Head Fundamentals9 Hours***Outcome: Describe the functions and design features of cylinder heads and valve train components.***

1. Explain the function, construction and design features of cylinder heads.
2. Describe the construction and design features of engine valves and related components.

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3. Describe the construction and design features of valve train components.
4. Identify cylinder head sealing and retention devices.

K. Cylinder Head Service 9 Hours

Outcome: *Service cylinder heads and valve train components.*

1. Demonstrate cylinder head removal and disassembly.
2. Clean and inspect cylinder heads.
3. Explain cylinder head and valve reconditioning procedures.
4. Inspect valve train components.
5. Demonstrate cylinder head assembly and installation.

L. Engine Braking System Fundamentals and Service 3 Hours

Outcome: *Explain the operation of engine compression and exhaust brakes.*

1. State the function of an engine brake.
2. Explain the operation of an engine compression brake.
3. Explain basic adjustment and diagnosis of an engine compression brake.
4. Explain the functions and operation of an engine exhaust brake.

SECTION TWO: ENGINE SYSTEMS 28 HOURS

A. Air Induction and Exhaust Systems 5 Hours

Outcome: *Service air induction, exhaust systems and related components.*

1. State the functions of an air induction system.
2. Identify and state the function of air induction system components.
3. State the function of an exhaust system.
4. Identify and explain the operation of exhaust system components.
5. Explain the service procedures for air induction and exhaust systems.
6. Explain the use of test equipment to measure air inlet restriction and exhaust backpressure.

B. Turbocharged Air Systems 5 Hours

Outcome: *Service turbocharged air induction systems.*

1. State the purposes for turbocharging the engine air induction system.
2. Explain the construction and operation of a turbocharged air induction system and components.
3. Test, inspect and service a turbocharger.
4. Explain the function, construction and testing procedures for typical aftercoolers/intercoolers.
5. Explain the function of variable displacement turbo technology and wastegate systems.

C. Lubrication Systems and Crankcase Ventilation 9 Hours

Outcome: *Service lubrication systems and related components.*

1. State the functions and characteristics of engine oil.
2. Describe the use of oil analysis as a diagnostic tool.

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3. Explain the operating principles of a typical lubrication system and related components.
4. State the purpose of crankcase ventilation systems.
5. Perform lubrication system inspection and service.
6. Diagnose and repair faults related to lubrication systems and components.

D. Cooling Systems (Liquid and Air) 9 Hours

Outcome: *Service liquid and air-cooling systems and related components.*

1. Explain the function of the engine cooling system.
2. Explain the operation and maintenance of an air-cooling system.
3. Explain the operation of a typical liquid cooling system and its components.
4. Perform engine liquid cooling system repair and maintenance.
5. Explain the functions and design features of temperature sensors and warning devices.

SECTION THREE: DIESEL FUEL INJECTION SYSTEMS..... 33 HOURS

A. Diesel Fuel and Storage Tanks (Machine and Bulk Storage) 3 Hours

Outcome: *Handle and store diesel fuel using safe and efficient practices.*

1. State the safety precautions, characteristics and properties of diesel fuel.
2. Explain diesel fuel storage concerns.
3. Identify construction requirements and design features of fuel storage and supply tanks.

B. Combustion Process and Starting Aids 4 Hours

Outcome: *Apply the theory of the combustion process to engine operation and diagnosis.*

1. Explain the characteristics and factors affecting the diesel engine combustion process.
2. Explain diesel engine emission concerns.
3. Identify and state the purpose of common combustion chambers.
4. Identify types and function of common diesel engine starting aids.

C. Fuel System Service 5 Hours

Outcome: *Explain the operation of a basic fuel injection system.*

1. Identify types and service procedures for common fuel filters.
2. Explain the operating principles and design features of common fuel transfer pumps.
3. Perform testing and diagnosis of a fuel transfer system.
4. Explain fuel transfer pump inspection and service procedures.

D. Basic Mechanical Fuel Injection System 6 Hours

Outcome: *Explain the operation of a basic fuel injection system.*

1. List the requirements of a fuel injection system.
2. Identify the layout and components of a basic fuel injection system.
3. Explain the function of the components required in the basic diesel fuel injection system.

E. Advanced Mechanical Fuel Injection System 9 Hours***Outcome: Explain the operation of an advanced mechanical fuel injection system.***

1. Explain the testing and timing procedures of port and helix fuel metering systems.
2. Explain the testing and timing procedures of inlet fuel metering for opposed plunger pump designs.
3. Explain the operating principles of hydraulic fuel injection nozzles.
4. Explain governor operation according to design characteristics and application.

F. Basic Diesel Engine and Fuel System Testing and Adjusting 5 Hours***Outcome: Explain basic testing and adjustment procedures on diesel engines and mechanical fuel injection systems.***

1. Explain the benefits of maintaining engine adjustments.
2. Explain engine performance testing and demonstrate diagnosis.

G. Emergency Shutdown Systems 1 Hour***Outcome: Explain the operating principles of engine shutdown and warning systems.***

1. Explain the operation of an engine emergency warning and shutdown systems that monitors oil pressure, coolant temperature, coolant level and engine over-speed.

SECTION FOUR: ELECTRONICS FUEL MANAGEMENT 54 HOURS**A. Electronic Fuel System Fundamentals 15 Hours*****Outcome: Retrieve and interpret basic diagnostic information from a typical diesel engine electronic control system.***

1. Explain the operation of a computer controlled fuel injection system.
2. Explain the operation of engine sensors that measure pressure, temperature, speed, fluid level, and throttle position.
3. Explain integral warning, shutdown and fault codes systems used with electronic controls.
4. Demonstrate the use of a personal computer (PC) and other appropriate tools for electronic system interface.
5. Demonstrate the adjustment of electronic fuel control system parameters.

B. Electronically Controlled Fuel Injection Systems 12 Hours***Outcome: Identify and explain components of electronically controlled fuel injection systems.***

1. Explain the operation of an electronic unit fuel injection system.
2. Explain the operation of a hydraulic electronic unit injection (HEUI) fuel injection system.
3. Explain the operation of a common rail fuel injection system.
4. Explain the operation of an electronic unit pump fuel injection system.

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C. Electronic Fuel System Diagnosis 12 Hours

Outcome: *Diagnose and service electronic controlled diesel fuel injection systems.*

1. Diagnose and repair an electronic fuel control system malfunction.
2. Demonstrate removal and installation procedures of an electronic fuel pump or injector.

D. Emission Control/After Treatment Systems 15 Hours

Outcome: *Explain the operation of emission control systems.*

1. State the purposes of an emission control system to Environmental Protection Agency (EPA) guidelines.
2. Describe the theory of Exhaust Gas Recirculation (EGR)
3. Explain the purpose of Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPI).
4. Explain the purpose of a Selective Catalyst Reduction (SCR) and Diesel Exhaust Fluid (DEF).
5. Explain effect on other vehicle systems; fuel, oil, coolants, intake/turbo systems.
6. Discuss emerging technologies.

SECTION FIVE:HEAVY DUTY CHARGING AND CRANKING SYSTEMS..... 50 HOURS

A. Charging System and Control Circuit Fundamentals 12 Hours

Outcome: *Explain the operation of 12 volt and 24 volt charging systems.*

1. Explain the purpose of the charging system in relation to equipment operation.
2. Identify charging system components.
3. Describe the operational characteristics of an alternator.
4. Identify and state the function of common alternator components.
5. Describe the operation of an alternator in regards to induction, rectification and output control.
6. Identify the variations to common alternator designs.
7. Identify common regulator types and designs.
8. State the purpose of auxiliary terminals on integrally regulated alternators.
9. Explain the operation of charging system indicator circuits.

B. Charging System Testing and Service 18 Hours

Outcome: *Diagnose and service 12 volt and 24 volt charging systems.*

1. Perform on-equipment charging system tests.
2. Demonstrate the procedure to test an alternator for output and voltage control.
3. Identify alternator defects.
4. Demonstrate charging system maintenance procedures.

C. Cranking System Fundamentals and Motor Drives 3 Hours

Outcome: *Explain the operation of 12 volt and 24 volt cranking systems.*

1. Identify components of a typical cranking system.
2. Describe the principles of operation of a cranking motor.
3. Identify cranking motor construction in regards to electrical design.

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4. Identify and state the function of common cranking motor components.
5. Identify and explain the operation of overrunning clutch type motor drives.
6. Explain operational limitations of a cranking motor.

D. Cranking System Control Circuits 3 Hours

Outcome: *Explain the operation of cranking motor control circuits.*

1. Trace a cranking system circuit diagram.
2. Explain the operation of a cranking motor solenoid switch.
3. Explain the operation of a magnetic switch.

E. Cranking System Testing and Service 12 Hours

Outcome: *Diagnose and service cranking systems.*

1. Perform on-equipment cranking system diagnostics.
2. Identify cranking motor defects by no-load test results.
3. Demonstrate the procedure to bench test a cranking motor.
4. Diagnose possible cranking system failures from specific symptoms.

F. Non-Electric Cranking Systems 2 Hours

Outcome: *Service and maintain air and hydraulic cranking systems.*

1. State the function, system requirements and troubleshooting procedures required on air cranking systems.
2. State the function, system requirements and troubleshooting procedures required on hydraulic motor cranking systems.

**THIRD PERIOD TECHNICAL TRAINING
HEAVY EQUIPMENT TECHNICIAN TRADE
COURSE OUTLINE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO
PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:.....HYDRAULICS II 114 HOURS

A. Hydraulic Principles 9 Hours

***Outcome:* Explain principles of hydraulics.**

1. Explain the principles of hydraulic energy transfer.
2. State the characteristics of hydraulic oil.
3. Explain common hydraulic contamination control methods.

B. Hydraulic Pump Fundamentals 9 Hours

***Outcome:* Identify common hydraulic pumps.**

1. Explain common hydraulic pump configurations.
2. Explain gear pump operating principles.
3. Explain vane pump operating principles.
4. Explain piston pump operating principles.

C. Hydraulic Pump Service 12 Hours

***Outcome:* Diagnose and repair common hydraulic pumps.**

1. Explain start up procedures and precautions.
2. Service a gear pump.
3. Service a vane pump.
4. Service a piston pump.

D. Hydraulic Actuator Fundamentals 6 Hours

***Outcome:* Identify hydraulic cylinders and motors.**

1. Explain the operating principles of hydraulic cylinders.
2. Explain the operating principles of hydraulic motors.

E. Hydraulic Actuator Service 9 Hours

***Outcome:* Service hydraulic cylinders and motors.**

1. Service hydraulic cylinders.
2. Service hydraulic motors.

F. Hydraulic Valve II 18 Hours***Outcome: Service hydraulic pressure, flow and directional control valves.***

1. Explain the operation and service procedures of hydraulic pressure control valves.
2. Explain the operation and service procedures of hydraulic flow control valves.
3. Explain the operation and service procedures of hydraulic directional control valves.
4. Explain the operation and service procedures of directional control valve accessories.
5. Explain methods used to connect multiple directional control valves.

G. Hydraulic System Types 18 Hours***Outcome: Analyze common mobile equipment hydraulic systems.***

1. Interpret common mobile equipment hydraulic system schematics.
2. Explain the operation of mobile open centre hydraulic systems.
3. Explain the operation of mobile closed centre hydraulic systems.
4. Explain the operation of a mobile hydrostatic transmission hydraulic system.

H. Hydraulic System Testing and Service 18 Hours***Outcome: Diagnose common mobile equipment hydraulic systems.***

1. Perform visual inspection and operational tests on common hydraulic systems.
2. Perform pressure and flow testing on common hydraulic systems.
3. Determine hydraulic system faults.

I. Electrohydraulics 15 Hours***Outcome: Analyze basic electrical and electronically controlled hydraulic systems.***

1. Explain the operating principles of electrically controlled hydraulic system components.
2. Explain the operating principles of electronically controlled hydraulic system components.
3. Explain joystick and pulse width modulated control systems.
4. Diagnose electrohydraulic system faults.

**SECTION TWO:..... STEERING AND SUSPENSION SYSTEMS AND ACCESSORIES 33 HOURS
(SPECIFIC TO OFF-ROAD) AND APPRENTICESHIP****A. Wheeled Equipment Steering Fundamentals and Service 6 Hours*****Outcome: Diagnose and service off-road equipment steering systems.***

1. Identify common off-road steering configurations and applications.
2. Identify full time power steering system components.
3. Explain the operation of common off-road power steering systems and components.
4. Explain off-road power steering system diagnostic and service procedures.
5. Identify skid steering system components.
6. Explain the operation of a skid steering system.
7. Explain skid steering system diagnostic and service procedures.

B. Suspension System Fundamentals and Service 5 Hours***Outcome: Explain off-road suspension system diagnostic and service procedures.***

1. State the functions and applications of common off-road suspension systems.
2. Explain the operation of a motor scraper cushion hitch system.
3. Explain cushion hitch diagnostic and service procedures.
4. Explain the operation of common haul truck suspension systems.
5. Explain common haul truck suspension system diagnostic and repair procedures.

C. Off-Road Equipment Accessories and Attachments 5 Hours***Outcome: Service and maintain accessories and attachments used with off-road equipment.***

1. Explain the functions and operating principles of operator protective structures.
2. Explain operator protective structures in regards to service and maintenance precautions.
3. Identify and explain the purpose of automatic fire suppression systems used on off-road equipment.
4. Identify and explain the functions of common ground engaging tools and tool mounting components.
5. Explain the procedures required to service common ground engaging tools.
6. Explain the operating principles and service procedures required for common types of winches.

D. Off-Road Electrical Circuit Fundamentals 8 Hours***Outcome: Explain the operation of typical off-road equipment electrical and warning circuits.***

1. Explain the operation of off-road equipment lighting circuits.
2. Explain the operation of off-road equipment accessory circuits.
3. Explain the operation of audible and visual warning devices.
4. Explain multiplexing systems in off-road equipment.

E. Off-Road Electrical Circuit Service 6 Hours***Outcome: Diagnose and repair off-road equipment electrical circuits.***

1. Perform basic test procedures on off-road equipment lighting circuits.
2. Perform basic test procedures on off-road equipment accessory circuits.
3. Explain precautions when servicing electronic dash systems.

F. Workplace Coaching Skills 1 Hour***Outcome: Display coaching skills.***

1. Describe coaching skills used for training apprentices.
 - a) Identifying the point of the lesson.
 - b) Linking the lesson.
 - c) Demonstrating a new skill.
 - d) Providing the opportunity to practice a skill.
 - e) Giving feedback to the learner.
 - f) Assessing the apprentices learning progress.

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G. Advisory Network 1 Hour

Outcome: *Describe the advisory network.*

1. Explain the role and purpose of the advisory network, local apprenticeship committee, and provincial apprenticeship committee.

H. Interprovincial Standards 1 Hour

Outcome: *Discuss Red Seal/Interprovincial Standards.*

1. Describe the National Occupational Analysis (NOA).
2. Describe the relationship between the NOA and Red Seal / Interprovincial examinations.
3. Discuss the roles of federal and provincial government in the development of Red Seal standards.
4. Discuss the role of industry in the development of Red Seal standards.
5. Explain the intent of the Red Seal exam as it relates to interprovincial mobility.
6. Describe sources of information on Red Seal standards and practice examination.

SECTION THREE: POWERTRAIN (SPECIFIC TO OFF-ROAD) 93 HOURS

A. Gearing Principles 3 Hours

Outcome: *Explain basic gearing principles.*

1. Define gear terminology.
2. Explain gear relationships with regards to ratios and input/output direction.
3. Identify common gear types and applications.

B. Torque Converter Fundamentals and Service 9 Hours

Outcome: *Diagnose and repair common off-road equipment torque converters.*

1. Describe the function and concepts of fluid converters.
2. Describe the components and operation of torque converters.
3. Explain the operation of a torque divider.
4. Explain basic torque converter mounting, diagnostic and repair procedures.

C. Powershift and Automatic Transmission Mechanical/Electronic Components 14 Hours

Outcome: *Explain the operation of powershift and automatic transmission mechanical components.*

1. Compare functions and applications of powershift and automatic transmissions.
2. Explain gearing principles of single and multiple planetary gear sets.
3. Explain the operation of a typical planetary type transmission.
4. Explain the operation of typical countershaft type powershift/automatic transmissions.

D. Powershift and Automatic Transmission Control and Shifting 9 Hours

Outcome: *Explain the operation of powershift and automatic transmission shift control mechanisms.*

1. Explain the operation of hydraulic shift control systems for powershift transmissions.

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2. Explain the operation of hydraulic shift control systems for automatic transmissions.
3. Explain the operation of electronic shift control systems for automatic transmissions.

E. Hydraulic Retarder Fundamentals 3 Hours

Outcome: *Explain the operating principles for off-road equipment hydraulic retarders.*

1. Identify the components of a typical off-road equipment hydraulic retarder.
2. Explain the operation of a typical off-road equipment hydraulic retarder.

F. Powershift and Automatic Transmission Testing and Service 9 Hours

Outcome: *Diagnose and service powershift and automatic transmissions.*

1. Perform powershift and automatic transmission visual inspections and operational tests.
2. Perform powershift and automatic transmission hydraulic shift control system testing.
3. Perform powershift and automatic transmission electronic shift control system testing.
4. Explain the procedures to remove and reinstall a powershift and automatic transmission.

G. Tracked Equipment Steering Fundamentals and Service 10 Hours

Outcome: *Explain tracked equipment steering system diagnostic and service procedures.*

1. Explain the operation of a steering clutch and brake crawler tractor steering system.
2. Explain the diagnostic and service procedures for a steering clutch and brake crawler tractor steering system.
3. Explain the operation of a hydrostatic crawler tractor steering system.
4. Explain diagnostic and service procedures for a hydrostatic crawler tractor steering system.
5. Explain the operation of a differential type crawler tractor steering system.
6. Explain the diagnostic and service procedures for a differential type crawler tractor steering system.

H. Undercarriage Systems Fundamentals and Service 11 Hours

Outcome: *Explain diagnostic and service procedures for tracked equipment undercarriage and related components.*

1. Describe the functions, applications and configurations of undercarriage systems.
2. Explain the functions and operation of the components of typical undercarriage systems.
3. Perform undercarriage inspection and adjustment procedures.
4. Explain the procedures required for safely removing and replacing undercarriage components.
5. Explain procedures for remanufacturing undercarriage components.

I. Final Drive Fundamentals and Service (Off-Road) 10 Hours

Outcome: *Explain diagnostic and service procedures for off-road equipment final drive systems.*

1. Describe the functions, applications, and configurations of final drive systems.
2. Explain the operation of wheeled equipment final drive systems.
3. Explain the fundamentals of alternating current (ac) drive systems.
4. Explain the safety precautions when servicing units equipped with ac drive systems.

5. Explain the operation of tracked equipment final drive systems.
6. Explain maintenance and service procedures for final drive systems.

J. Drive Axle and Carrier Fundamentals and Service (Off-Road) 12 Hours

Outcome: *Repair drive axle and carrier assemblies.*

1. State the functions of single reduction drive axle assemblies.
2. Identify single reduction drive axle components.
3. Explain the operating principles of a single reduction drive axle and differential assembly.
4. Identify common types of carrier assemblies used in the trade.
5. Explain the lubrication of a single reduction drive axle.
6. Diagnose a drive axle and carrier assembly for operational faults.
7. Explain drive axle and carrier assembly removal and replacement procedures.
8. Overhaul a typical drive axle and carrier assembly to manufacturer's specifications.

K. Clutch Fundamentals and Service 3 Hours

Outcome: *Service and diagnose common clutch types.*

1. Explain the operation and maintenance of overcentre clutches.
2. Explain the operation principles of special application clutches such as overrunning, dog, cone and bevel and electromagnetic.

**FOURTH PERIOD TECHNICAL TRAINING
HEAVY EQUIPMENT TECHNICIAN TRADE
COURSE OUTLINE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO
PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:.....POWERTRAIN (SPECIFIC TO TRUCK AND TRANSPORT) 122 HOURS

A. Clutch Fundamentals and Service 9 Hours

Outcome: Service and diagnose common clutch types.

1. Explain the function and operating principles of spring-loaded clutch systems.
2. State the function of spring-loaded clutch components.
3. Diagnose spring-loaded clutch operating faults.
4. Perform service procedures for spring-loaded clutches.
5. Explain the function and operating principles of auto adjust clutches.
6. Explain the function and operating principles of the no pedal clutch systems.

B. Driveline Fundamentals and Service 12 Hours

Outcome: Diagnose and service drivelines and universal joints.

1. Explain the function and operating principles of common driveline assemblies.
2. Explain the construction and design features of common driveline components.
3. Diagnose and service universal joints.
4. Explain and check driveline phasing, angles and angle limitations.
5. Explain the procedure to rectify driveline vibrations.

C. Gearing Principles 3 Hours

Outcome: Explain basic gearing principles.

1. Define gear terminology.
2. Explain gear relationships with regards to ratios and input/output direction.
3. Identify common gear types and applications.

D. Transmission Fundamentals 13 Hours

Outcome: Explain the principles of operation and design features of mechanical transmissions.

1. Explain vehicle powertrain requirements in relation to engine performance characteristics and vehicle applications.
2. Explain the operation of a synchronizer.
3. Explain the operating principles of transmission main section mechanical components.
4. Explain the operation of transmission auxiliary section mechanical components.
5. Explain the lubrication of transmissions.

6. Explain the fundamentals of Hybrid drive systems.
7. Explain the safety precautions of Hybrid drive systems.

E. Transmission Shifting 12 Hours

Outcome: *Explain mechanical and electronic transmission shift controls.*

1. Explain the operation of the components of a mechanical air shift system.
2. Explain mechanical transmission air shift system operation.
3. Explain the operating principles of an electronic automated top gear shifting system.
4. Explain the basic operation of mechanical transmission electronic shift controls.

F. Transmission Service..... 27 Hours

Outcome: *Repair mechanical transmissions.*

1. Explain how to service and maintain constant mesh transmissions.
2. Diagnose operational faults associated with typical constant mesh transmissions.
3. Overhaul a non-synchromesh transmission to manufacturer's specifications.
4. Overhaul a synchromesh transmission to manufacturer's specifications.
5. Perform failure analysis on the components of a typical constant mesh transmission.
6. Explain transmission installation procedures.
7. Perform air shift system diagnosis and troubleshooting.
8. Explain the safety precautions when servicing vehicles with Hybrid drive systems.

G. Transfer Case and Auxiliary Drives 4 Hours

Outcome: *Explain the operating principles and repair procedures of transfer cases and auxiliary drive units.*

1. Explain how to service and maintain constant mesh transmissions.
2. Explain the diagnosis and service of a typical transfer case.
3. Explain the principles of operation and design features of typical power takeoff (PTO) units.
4. Explain PTO installation procedures and precautions.
5. Explain PTO diagnosis and service procedures.

H. Drive Axle Assembly Fundamentals (On-Road) 12 Hours

Outcome: *Explain the functions and operating principles of drive axle assemblies.*

1. Explain drive axle requirements in relation to vehicle applications.
2. State the functions of a drive axle assembly.
3. Identify drive axle configurations and components.
4. Explain the operating principles of a differential assembly.
5. Explain the operating principles of an inter-axle differential assembly.
6. Explain common axle shaft configurations.
7. Explain the lubrication of a drive axle.
8. Explain the operating principles of wheel lock assemblies.

I. Drive Axle Assembly Service (On-Road).....30 Hours***Outcome: Repair drive axle assemblies.***

1. Diagnose a drive axle assembly for operational faults.
2. Explain differential carrier assembly removal and installation procedures.
3. Overhaul a typical differential carrier assembly to manufacturer's specifications.
4. Overhaul a typical inter-axle differential assembly.

SECTION TWO:..... STEERING SYSTEMS AND ANTILOCK BRAKE SYSTEMS 48 HOURS**A. Steering Fundamentals 8 Hours*****Outcome: Diagnose truck steering systems.***

1. Explain the operating principles of steering systems.
2. Explain the construction and design features of steering components.
3. Identify the components of a truck power steering system.
4. Explain the operation of power steering system components.

B. Steering Service 10 Hours***Outcome: Diagnose and service truck steering systems.***

1. Explain steering component service procedures.
2. Diagnose power steering system faults.
3. Explain hydraulic system testing and adjustment procedures.
4. Describe the procedures required to remove and replace power steering components.
5. Describe the procedures for adjusting an integral power steering gearbox.
6. Service a power steering gear.

C. Steering Angles and Alignment 8 Hours***Outcome: Identify steering angles and their effects on vehicle handling.***

1. Explain steering system geometric principles and their effects on vehicle handling and tire wear.
2. List pre-alignment inspection procedures.
3. Describe common methods of adjusting wheel alignment angles to achieve manufacturer's guidelines.

D. Air Antilock Brake Systems 6 Hours***Outcome: Explain the operation of antilock braking systems (ABS) and automatic traction control (ATC) systems.***

1. Explain the operation of an antilock brake systems (ABS).
2. Explain the operation of the individual ABS components.
3. Explain the interface between the tractor and the trailer.
4. Explain the operation of the individual ATC components.
5. List ABS and ATC service precautions.
6. Explain the operation of roll stability systems.

E. Air Antilock Brake System Diagnosis.....8 Hours***Outcome: Diagnose and service air antilock braking systems (ABS).***

1. Explain a logical procedure to troubleshoot an air ABS.
2. Identify service tools for ABS diagnosis.
3. Describe methods used to test failed ABS components.
4. Diagnose and repair ABS faults.

F. Hydraulic Antilock Brake Systems8 Hours***Outcome: Explain the operation of typical hydraulic antilock braking systems (ABS).***

1. Identify the components of a hydraulic ABS.
2. Explain hydraulic system operation.
3. Explain electronic system operation.
4. Describe hydraulic ABS service and diagnostic procedures.
5. Demonstrate the procedure to bleed a hydraulic ABS.

SECTION THREE: AIR CONDITIONING 36 HOURS**A. Air Conditioning Fundamentals8 Hours*****Outcome: Explain the operating principles of basic air conditioning systems.***

1. Explain the thermodynamic principles related to air conditioning.
2. Explain the properties and handling precautions of refrigerants and refrigerant oils.
3. Identify the basic components of an air conditioning system.
4. Explain the operation of a clutch cycling air conditioning system using an expansion valve or an orifice tube.

B. Heating, Ventilation and Air Conditioning (HVAC) Control Systems12 Hours***Outcome: Explain the operating principles of heating, ventilation and air conditioning (HVAC) control systems.***

1. Identify the components of an air conditioning control system.
2. Explain the operation of air conditioning control systems.
3. Identify the components of an automatic temperature control system.
4. Identify the components of an air distribution system.
5. Explain the operation of an air distribution system.
6. Explain the operation of a typical sleeper temperature control system.
7. Explain the procedure to test HVAC control system operation.

C. Air Conditioning Testing and Service.....16 Hours***Outcome: Diagnose and service air conditioning systems.***

1. State the safety precautions required when servicing air conditioning systems.
2. Identify air conditioning service tools.
3. Perform air conditioning system diagnosis.

4. Perform air conditioning service within legislated guidelines.
5. Explain replacement procedures for defective air conditioning components.

**SECTION FOUR: VEHICLE ELECTRICAL DIAGNOSIS,..... 34 HOURS
FAILURE ANALYSIS AND APPRENTICESHIP**

A. Truck Electrical Circuit Fundamentals 8 Hours

Outcome: *Explain the operation of typical truck electrical and warning circuits.*

1. Explain the operation of truck lighting circuits.
2. Explain the operation of truck accessory circuits.
3. Explain the operation of audible and visual warning devices.
4. Explain multiplexing systems in on highway equipment.

B. Truck Electrical Circuit Service 9 Hours

Outcome: *Diagnose and repair truck electrical circuits.*

1. Perform basic test procedures on truck lighting circuits.
2. Perform basic test procedures on truck accessory circuits.
3. Explain precautions when servicing electronic dash systems.
4. Describe safety precautions related to supplemental restraint systems (SRS).

C. Failure and Fluid Analysis 8 Hours

Outcome: *Explain predictive maintenance procedures utilizing failure and fluid analysis.*

1. Explain fluid (oil and coolant) analysis.
2. Explain basic failure analysis.

D. Orientation to Vehicle Inspection 6 Hours

Outcome: *Explain truck inspection according to Commercial Vehicle Inspection (CVI) regulations.*

1. Outline provincial truck inspection regulations.
2. Identify conditions caused by damage, wear or corrosion that would make a truck unsafe or inoperable.
3. Identify conditions that would require further inspection.

E. Workplace Coaching Skills 1 Hour

Outcome: *Display coaching skills.*

1. Describe coaching skills used for training apprentices.
 - a) Identifying the point of the lesson.
 - b) Linking the lesson.
 - c) Demonstrating a new skill.
 - d) Providing the opportunity to practice a skill.
 - e) Giving feedback to the learner.
 - f) Assessing the apprentices learning progress.

F. Advisory Network 1 Hour

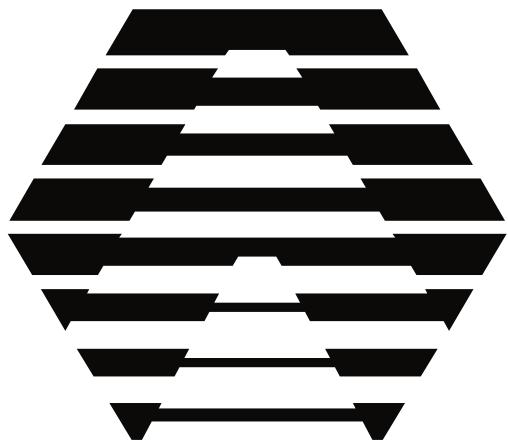
Outcome: Describe the advisory network.

1. Explain the role and purpose of the advisory network, local apprenticeship committee, and provincial apprenticeship committee.

G. Interprovincial Standards..... 1 Hour

Outcome: Discuss Red Seal/Interprovincial Standards.

1. Describe the National Occupational Analysis (NOA).
2. Describe the relationship between the NOA and Red Seal / Interprovincial examinations.
3. Discuss the roles of federal and provincial government in the development of Red Seal standards.
4. Discuss the role of industry in the development of Red Seal standards.
5. Explain the intent of the Red Seal exam as it relates to interprovincial mobility.
6. Describe sources of information on Red Seal standards and practice examination.



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